

Three-Phase VSP and Geomechanics Integration for ONGC Deepwater Wildcat Well

Case study: Target depth extended and accurate, narrow mud-weight window predicted in eastern India

Challenge

Predict mud-weight window for drilling in an ultradeepwater environment with challenging pressure gradients.

Solution

Apply a borehole seismic and geomechanics collaborative team to create a predrill model, populate with vertical seismic profile (VSP) data, and predict look-ahead velocities and pore pressure changes.

Results

Extended target depth by 3,281 ft and achieved an optimal mud-weight window that prevented losses and allowed the well to be drilled safely.

Instability in conventional prediction methods

After facing depth uncertainty, kicks, and wellbore instability in deepwater wells off the east coast of India, Oil and Natural Gas Corporation (ONGC) was apprehensive about potential unexpected pore pressure regimes in a wildcat well where the nearest drilled well was 62 miles away.

Previous methods for pore pressure and mud-weight prediction used surface seismic interval velocities to generate a look-ahead model. Using this approach, ONGC experienced heavy mud loss, wellbore instability (Fig. 1), and target depth uncertainties, making the company unable to reach planned TD. For the wildcat well, the company sought an approach to remove these drilling problems.

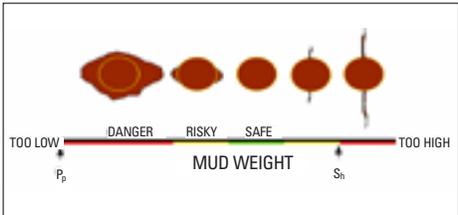


Figure 1: Wellbore stability and relative mud weight window.

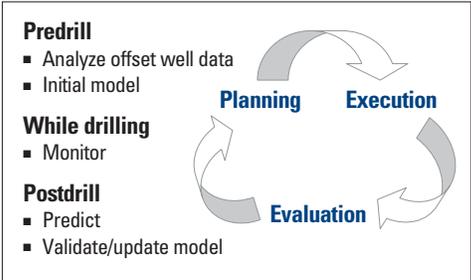


Figure 2: Project phases: Planning, Execution, and Evaluation.

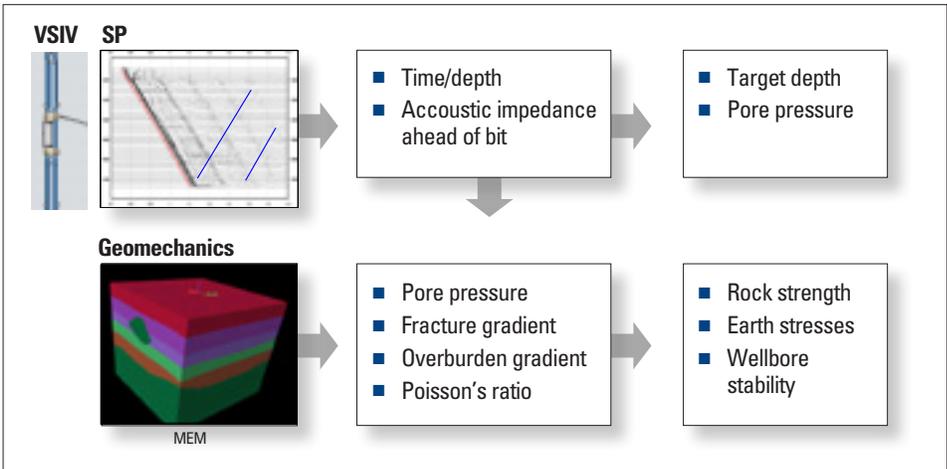


Figure 3: Integrated workflow to estimate safe mud weight window using VSP and geomechanics.

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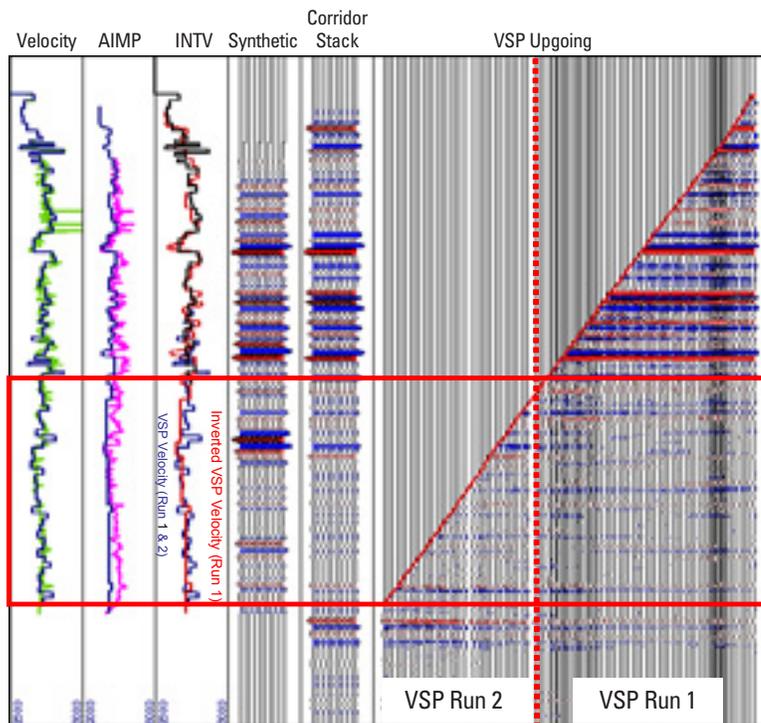


Figure 4: VSP look-ahead interval velocity from Run 1 (predrill), showing good match with the interval velocity recorded from Run 2 VSP (postdrill).

“An integrated approach toward data acquisition, analysis, and interpretation led to a much more comprehensive understanding of the subsurface than has previously been possible. The workflow and solution provided by Schlumberger made for a timely implementation, whereby we could avoid drilling surprises in the wildcat well. This led to savings in terms of time and money.”

Sundaram KM, ONGC

Mud-weight estimation with VSP look-ahead

Together with borehole seismic and geomechanics experts from Schlumberger, ONGC carried out the project in three phases (Fig. 2). First, a representative predrill pressure profile model was created using the nearest available well data. Then, upon drilling the surface section, the team updated the model with drilling data, cutting samples, LWD measurements, wireline logs, and a VSP. VSP data was inverted (Fig. 4) over the section to predict interval velocities ahead of the bit (called a look-ahead), and a calibrated model was completed using wireline sonic data. Finally, from the calibrated model, the team used the predicted velocities to estimate pore pressure, fracture gradient, and a safe mud-weight window (Fig. 3).

The process was completed in four sections of the well with drilling data and well logs delivered in relevant time. Results were supplied to the team within 4 to 5 hours of receiving the data, allowing rig operators to make optimal and fact-based decisions in a timely manner.

Deeper target depth, accurate mud weight window

The integrated workflow gave ONGC the approach it needed to perform safer and more economic drilling operations. The predicted mud-weight window was accurate to ± 0.2 lbm/galUS up to 1,804 ft ahead of the bit, preventing potential loss due to wellbore instability and breakout. ONGC also extended the target depth by 3,281 ft with the same casing strings. This well was the first in the area to have near-real-time data monitoring, and to date it is the deepest well drilled off the Indian east coast.

Contact your local Schlumberger representative to learn more.

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